Table 2. Implementation studies of the World Health Organization Surgical Safety checklist

Author/Year	Description of PSP	Study Design	Theory or Logic Model	Description of Organization	Safety Context
Sewell 2011[24]	2008 WHO surgical checklist, unmodified	Before and after study, comparing pre-training period to post-training	"The underlying philosophy of the checklist is that a true team approach with good communication between operating room team members is safer and more efficient than a hierarchical system that relies on individuals"	A U.K. hospital, orthopedic operations. 28% of operations were urgent, and 77% involved general anesthesia	Pre-training period Feb-May 2009 (480 operations). During this period: Correct checklist use 8%, and 47% thought it improved team communication Pre-training staff perceptions: 55% thought it caused an unnecessary time delay, 28% thought it improves patient safety, 47% thought it improves team communication and teamwork, 64% would want the checklist used if they were having an operation
Helmio 2011[55]	2008 WHO surgical checklist. No specialty-related changes, but some "minor changes." Checklist included in publication; modifications did not exclude any items	Before and after study	"The idea of the checklist is to be an add-on security tool for the defined safety standard"	Finland, otorhinolaryngology-head and neck surgery ORs. 747 operations in the two month study periods combined. All subgroups of otorhinolaryngology-head and neck surgery were included.	One-month pre-implementation period in May 2009 (304 operations). 17% were urgent operations. 24% were on children. 16% were local anesthesia. Before implementation: Knowledge of OR-teams' names and roles ranged from 61 % to 92%. Discussing risks was 24%. Postop instructions recorded 74%-84%. Successful communication 79%-93%.

Author/Year	Description of PSP	Study Design	Theory or Logic Model	Description of Organization	Safety Context
Conley 2011[28]	2008 WHO surgical checklist, unmodified	Case series	None explicitly stated.	Five Washington state hospitals. Two hospitals had <10 ORs, one had 10-20, and two had >20. Two urban, two suburban, and one rural.	Nothing reported about pre-existing safety culture. The Vice President for Patient Safety at the Washington State Hospital Association provided "significant assistance." Checklist introduction Dec 2008 to Jan 2009. Interviews conducted Sept - Dec 2009. One of the five hospitals had a recent wrong-site incision that motivated surgical staff and "opened people's eyes to the need for ongoing patient safety efforts"
Bell 2010[56,57]	2008 WHO checklist adapted different for different surgical specialties. Checklist not included in publication.	Case series	"Without a doubt, the checklist works best when all staff members are engaged"	Large two-hospital Trust in the U.K. with 10,000 staff and 850,000 patients annually.	Nothing about pre-existing safety culture. To prepare for the checklist, they set up a Patient Safety Working Group
Sparkes 2010[58]	2008 WHO checklist locally adapted. Checklist included in publication; modifications did not exclude any items	Case series	Discussed various ways a checklist could enhance safety, including teamwork and effective communication	Teaching hospital in the U.K. with 29 ORs in five locations performing specialized complex surgery	NR
Royal Bolton 2010[36]	2008 WHO checklist, unmodified. Local adaptation of it was considered but ultimately not done.	Case series	Improve patient safety by enhancing teamwork and communication	Trust in the U.K. with eight ORs	Prior to the checklist, the trust already had a core group of patient safety experts assembled; this group met to discuss how to introduce the checklist. They examined the previous year's 41 safety incidents and all were "found to be avoidable had the checklist been in use"

Author/Year	Description of PSP	Study Design	Theory or Logic Model	Description of Organization	Safety Context
Vats 2010[26]	2008 WHO surgical checklist adapted for England and Wales. Checklist included in publication; modifications did not exclude any items	Case series	"…the checklist ensures that critical tasks are carried out and that the team is adequately prepared for the operation"	U.K. academic hospital	Nothing reported about pre-existing safety culture. Piloted March-Sept 2008 at a London hospital in 58% of operations (424/729) among the two ORs selected (one for trauma/orthopedics OR, the other for GI/GYN).
Kearns 2011[25]	WHO surgical checklist, version NR. Some obstetric-specific checks had been added, but the list of revisions was not reported. Checklist not included in publication.	Before and after study	"Checklists may be used to improve patient safety by ensuring that all elements of a practice are instituted for each new clinical event."	U.K. study in obstetrics ORs. Tertiary referral obstetric center with ~6,400 deliveries per year.	Before introducing the checklist, they measured staff attitudes, preserving respondent anonymity: 30% "felt familiar" with others in the OR 81% felt communication could improve 85% felt that in elective cases the checklist would be useful 53% felt that in emergency cases the checklist would be inconvenient
Norton 2010[59]	2008 WHO checklist modified for pediatric operations and also to meet the 2009 Joint Commission Universal Protocol. Checklist included in publication. Removed the following three items from the WHO checklist: pulse oximetry, difficult airway, anticipated blood loss	Case series	Checklist can help to reduce breakdowns in communication, ineffective teamwork, and lack of compliance with process measures	Children's hospital in the US performing numerous types of pediatric surgery	At this hospital they had been building a quality infrastructure for five years prior, and had already implemented the Universal Protocol.
Styer 2011[29]	2008 WHO checklist modified and implemented as hospital policy. Selected modifications listed. Checklist not included in publication.	Qualitative description	Implementing checklist using a Plan-Do-Study-Act (PDSA) cycle stepwise approach leads to smoother transition and sustained outcomes.	Teaching hospital in the US with 44 ORs	"This initiative…was introduced to see how the checklist might fit within our hospital culture."

Author/Year	Description of PSP	Study Design	Theory or Logic Model	Description of Organization	Safety Context
Bittle 2011[60]	2008 WHO checklist adapted for individual hospital. Checklist not included in publication.	Qualitative description	Checklists "ensure there is adherence to proven standards or care".	Large city hospital in New Zealand	Quality service improvement team
Yuan 2012[61]	2008 WHO checklist modified for local practice. Checklist included in publication.	Before and after study	Checklists are inexpensive and feasible way to potentially improve quality of surgical care in "resource-limited settings."	Two hospitals (each with 2 ORs) in Monrovia, Liberia. Hospital 1 (150 bed primary community hospital), Hospital 2 (200 bed, government referral hospital)	Liberia is rebuilding health system infrastructure after 14 years of conflict. Checklist implementation was a collaboration with the Ministry of Health and Social Welfare in Liberia to characterize its impact in low resource context.
Kasatpibal 2012[34]	2008 WHO checklist modified and translated. Hair removal added to checklist. Other modifications not described. Checklist not included in publication.	Case series	Checklists may reduce preventable adverse surgical events, but may be difficult or inappropriate to implement in a developing country.	University hospital in northern Thailand (1,400 beds, 21,877 operations annually)	Average rate of surgical site infection in Thailand is 1.7%.
Bohmer 2011[30]	2008 WHO checklist modified. Checklist included in publication.	Before and after	Checklists may improve staff's perception of patient safety and job satisfaction.	Institute for research in Operative Medicine of the University of Witten/Herdecke	NR
Fourcade 2012[27]	2008 WHO checklist modified. Checklist included in publication.	Case series 1) Random sample of 80 surgeries from each center performed over 18 day interval. 2) Interviews and surveys of participating staff	Checklists may improve surgical outcomes, but face barriers to efficient implementation.	18 cancer centers in France	The French National Authority for Health introduced a modified checklist as mandatory. Implemented by French National Federation of Cancer Centres along with research team from Coordination for Measuring Performance and Assuring Quality of Hospitals, Institut Gustave Roussy.

Author/Year	Description of PSP	Study Design	Theory or Logic Model	Description of Organization	Safety Context
Perez-Guisado 2012[62]	2008 WHO checklist. Checklist included in publication.	Descriptive cross sectional study of plastics, reconstructive surgical procedures	Checklist "involves new philosophy of organization that is easier to achieve in health workers with lower hierarchy" (i.e., nurses, surgeon residents	Reina Sofia Hospital (1,684 surgeries)	NR
van Klei 2012[33]	2008 WHO checklist modified. Checklist available in supplementary material.	Before and after	Checklists enhance teamwork and improve handovers decreased avoidable errors and complications.	University Medical center Utrecht (The Netherlands)	Checklist implemented in accordance with mandatory policy by the Dutch Health Care Inspectorate
Takala 2011[63]	2008 WHO checklist, modified. Checklist available in appendix.	Before and after	"Checklist would improve awareness of safety-related issues and the fluency of operations as well as communication during surgery."	4 university teaching hospitals in Finland.	Pilot study to investigate usefulness of the checklist in a variety of surgical specialties to inform development of a national checklist.
Truran 2011[64]	2008 WHO checklist, modified. Checklist not included.	Before and after	The checklist may improve compliance with venous thromboembolism prophylaxis guidelines.	Hospitals in the United Kingdom	NR
Vogts 2011[32]	2008 WHO checklist, modified. Checklist included in appendix.	Case series	Checklists "promote communication and teamwork within the OR".	Auckland City Hospital, New Zealand	Checklist implemented 2 years prior.
Askarian 2011[35]	2008 WHO checklist. No modifications noted, checklist not included in publication.	Before and after	Checklist may improve patient safety by reducing surgical complications.	Referral educational hospital in Shiraz, southern Iran (374 beds, 6 ORs)	The Iranian Ministry of Health, Treatment and Medical Education approved nationwide use of checklist in 2009.
Levy 2012[31]	2008 WHO checklist modified. Modified checklist not included in publication.	Case series	Low fidelity of checklist execution may be a barrier to improving health outcomes.	Academic tertiary care children's hospital (Texas, USA)	Checklist compliance reported at 100%, but fidelity of checklist use is unclear.
Helmio 2012[15]	WHO checklist (unclear if modified). Checklist not included in publication.	Case series	"This checklist has reduced complications and deaths significantly."	Otorhinolaryngology department in four Finnish hospitals.	Checklist implemented in these hospitals during WHO pilot project in 2009.

Table notes: NR-Not reported; Int-Intervention; OR-Operating room; GI-Gastrointestinal; GYN-Gynecology

Table 3. Findings of implementation studies of the World Health Organization Surgical Safety checklist

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Sewell 2011[24]	Checklist forms placed in ORs, compulsory training video detailing correct and incorrect uses of the checklist, emphasis placed on all team members being responsible. Active discouragement of a simple tickbox approach. Checklist training was not associated with reductions in any complications or mortality	Training phase first (unreported duration). Post-training period June-Oct 2009 (485 operations). Correct checklist use 97%. 2 minutes. 20% thought it caused an unnecessary time delay.	"The initial implementation of the checklist was met with resistance by some operating room team members as there was a belief that many of the points were already in practice."	77% thought it improved team communication, 68% thought it improves patient safety, 80% would want the checklist used if they were having an operation	Early complications 8.5% before checklist training and 7.6% after. Mortality 1.9% before checklist training and 1.6% after. Lower respiratory tract infections 2.1% before checklist training and 2.5% after. Surgical site infection 4.4% before checklist training and 3.5% after. Unplanned return to OR 1.0% before checklist training and 1.0% after.
Helmio 2011[55]	Training involved a presentation from an outside expert and three 45 minute lectures. Specific guidelines were in the OR, and short instructions on the back of the checklist.	One-month implementation period in Sept 2009 (443 operations).	"Use of the checklist improved verification of patient identity, but this was still inadequate." "Our study confirms that the surgical checklist fits well into otolaryngology." "We recommend the use of this checklist in all operations"	"…overall, the operating room personnel were supportive." Anesthesiologists' knowledge about patients had improved as compared to the pre-implementation period. Preoperative check of anesthesia equipment increased from 71% to 84%. After implementation, staff were more likely to accurately report patient identity, procedure, and operative side. After implementation, there was improvement in: Knowledge of OR-teams' names and roles ranged from 81 % to 94%. Discussing risks was 38%. Postop instructions recorded 86%. Successful communication 87%-96%.	NR

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Conley 2011[28]	NR	Duration of rollout: <2 months at three hospitals, >6 months at two hospitals.	The key is whether the local champion can "persuasively explain why and adaptively show how to use the checklist." Implementation was incomplete at three hospitals: One cancelled attempts to implement the checklist due to "fear of insurmountable resistance and poor interdisciplinary communication" Another cancelled attempts because they were unable to move beyond pilot testing. The third had less effective implementation because of a laissez-faire leadership style; no training; staff understood neither why nor how the checklist could be implemented	Interviews conducted, but no quantitative summary of opinions provided. Three hospitals were discussed in detail.	NR
Bell 2010[56,57]	Training provided to prevent "teething problems." Instead of requiring paperwork, they used in each OR an A3 board (a drawing board about 14x20 inches) that was color-coded to aid completion. Publicity campaign in both hospitals.	Piloted the checklist at one of the two hospitals first.	"To implement the checklist effectively, it was essential to engage all staff to ensure the theatre team worked together." "Working with individuals to identify any gaps or issues with implementation." Currently it is "being used as standard throughout theatres"	"Communication and staff morale have definitely improved since the checklist was implemented."	NR

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Sparkes 2010[58]	"Extensive educational support and training"	3 month pilot, during which changes to the checklist were made. After the pilot, and training, the checklist was introduced to all 29 Ors in Nov 2009.	Even though people agreed with the checklist in theory, it was difficult to change attitudes and behaviors, particularly the senior team. The checklist was required to be signed by team members, and "This had led to the fear that legal colleagues will apportion blame to those who have signed the checklist when complications occur."	Before checklist introduction: "Although all found the checklist to be useful, many senior clinicians felt that such communication already took place informally, and that more paperwork would not add to safety." Audit of 250 cases in Feb 2010 found that team briefings occurred in 77% and time outs in 86%.	NR
Royal Bolton 2010[36]	Drop-in educational sessions which involve 120 participants	May and June of 2009 were spent getting the word out about plans to start using the checklist. Piloted first for one month in two of the Trust's hospitals in 62 operations. Sept 2009 was the trust-wide launch of the checklist. "Every Trust is different but implementing the checklist across the trust rather than a prolonged pilot period." Within the first week 33% of operations employed the checklist. By one month it was at 72%. Currently all eight ORs use it.	"The importance of communicating with and involving people beyond this core group was recognized straight away." "Essentially it is all about changing the culture, which can be a long process, but it's well worth it."	"The feedback we received from staff was very positive. Most people were keen to introduce the checklist as quickly as possible."	One-month pilot identified nine potential incidents that were avoided as a result of the checklist.

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Vats 2010[26]	Limited time given to training.	Checklist accelerated with use. Large variability in how the checklist was used: sometimes incompletely, hurried, dismissive replies, and without some key participants. Compliance was initially good, then fell when the research team was absent, and so the team had to re-enter ORs to encourage greater use. Compliance ranged from 42% to 80% in the six month period.	Need a local champion as well as local organizational leadership. Importance of being able to modify to fit local needs, for example there was no need to check pulse oximetry because it is already used always.	Anesthetists and nurses were "largely supportive." Some surgeons were "not very enthusiastic." Awkward self-introductions, takes time to achieve comfort, Steep interpersonal hierarchy, ID the patient BEFORE draping, not after. Complaints about duplication; perhaps a revised checklist could have less duplication	"At our hospital, we found no significant change in overall morbidity or mortality, which were already very low, after the introduction of the checklist. However, there was a noticeable improvement in safety processes such as timely use of prophylactic antibiotics, which rose from 57% to 77% of operations after the checklist was introduced."
Kearns 2011[25]	Training, humorous posters provided, and "all staff empowered to remind the team to perform the checklist if it was forgotten."	Compliance with the preoperative part of the checklist was 61% after three months and 80% after one year. Compliance with the postoperative part of the checklist was 68% after three months and 85% after one year.	Authors cited four contributors to success: allocation of responsibilities, local champion, sense of ownership by team members, and ongoing staff consultation.	Staff attitudes three months after checklist introduction: 50% now "felt familiar" with others in the OR. 70% felt communication had improved. 80% felt that in elective cases the checklist was useful. 30% felt that in emergency cases the checklist was inconvenient. Fifty-eight patients were asked whether they noticed the operating team performing a series of checks before the operation, and 75% said they did, and another 19% remembered it after being prompted. Of the combined 94%, they all disagreed with the idea that the checks would make them worried, and 93% said they were reassuring.	NR

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Norton 2010[59]	3x5 foot posters in each OR. Launch involved formal letter to staff, electronic training application, multiple in-service training sessions, and mention in hospital newsletter	December 2008 pilot test in six pediatric surgical services (general, neuro, orthopedic, otolaryngology, plastic surgery, and urology). Feb 2009 pilot test on the revised procedures, and more minor edits were made. "Go-live" date April 1, 2009 in all of the hospital's Ors. Surgical chiefs were local champions, and one nurse champion was paired with each surgeon champion. They divided the responsibility for leading the Time Out phase among all team members, and identified key speaking points. Compliance at Ors improved over time during this period from July 2009 to Feb 2010.	"Use of the Pediatric Surgical Safety Checklist encourages multidisciplinary teamwork and has brought increased communication to our Ors and in other areas."	Dec 2008 pilot test of 30 procedures had 80-90% compliance, with "overwhelmingly positive" feedback. "Team members have expressed satisfaction with the flow and content of the checklist".	Checklist caught one near miss during sign in (site not marked), several near missed during time out, (antibiotics not given, problems with consent forms, site marking not visible after draping, missing equipment), and sign out (one team realized a patient needed straight catheterization, and reviewing procedure name helped nurse documentation, one specimen was incorrectly labeled).

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Styer 2011[29]	Slide presentations, educational posters in ORs, one on one sessions, frequent email updates	Oct 2008, 2 week trial: Day 1. Checklist used by 2 surgeons. Anesthesia/nursing teams recruited to participate and provide same day feedback Day 2. Feedback incorporated, used in 4 ORs, with 8 surgeons. Dec 2008: Chiefs of nursing, surgery, anesthesiology and surgical services asked to endorse use as hospital policy. Feb 2008: Checklist team established (leaders from surgery, anesthesia, nursing), project manager, administrative fellow. March 2009: Staggered 14 week rollout to 44 ORs. Each surgical service allotted 4 dedicated weeks of attention (Wk1: Communication, Wk 2: Education, Wk 3: Go live, Wk 4: Follow up). During "go live" period, checklist team observer assigned to each surgery to educate, provide real time feedback, answer questions.	Early endorsement by executive leadership. Each discipline equally involved in leading effort. PDSA cycle method for gradual implementation. Real time feedback. Each discipline should lead a section of checklist. Provide data (process and outcome measures). Checklist adopted as hospital policy.	NR	Allergies: RN added recent new allergy to record. Antibiotics: Not given (3), wrong antibiotic for procedure (2), surgeon changed mind about giving antibiotic after confirming procedure, antibiotic left in another room. DVT: Scheduled procedure typically would not have required compression boots, but patient found tohave history of DVT Safety precautions: Heparin drip had not been discontinued. Plan for management of patient: Chest radiograph after procedure for unsuccessful central line placement had been forgotten

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Bitter 2011[60]	Quality division "coaches" educated OR teams about checklist, and benefits.	May 2010. "Coaches" from quality division assigned to OR to introduce checklist, first to plastics, then other specialties. Team meetings with coach, OR manager, specialty clinical nurse manager, head of surgical department and senior registrars preceded implementation. Feedback regarding checklist procedure obtained at 1, 3 weeks.	NR	Initially "staff were anxious and somewhat apprehensive, but it is now an established step in an operation and is carried out with confidence."	Incorrect surgery site pointed out by patient Reported incidents fell from 12 to 11 compared to reporting period of previous year.
Yuan 2012[14]	Certified registered nurse anesthestists (CRNAs) were identified as local leaders of surgical teams. CRNAs along with surgeons, OR staff participated in 2 week training of lectures, written materials and direct guidance. Large printed poster placed in ORs.	Two months prior and after. All patients followed prospectively for outcomes and complications until discharge or 30 days whichever came first.	Reasons for success: checklist implementation catalyzed efforts to procure equipment (i.e., pulse oximeter) necessary for safety processes. Reasons for failure include: 1) lack of consistent access to crucial resources (such as antibiotics, batteries). 2) Checklist "did little to change the entrenched hierarchy and relationship dynamics of OR staff" 3) Lack of sustained checklist training beyond 2 weeks.	"…the checklists's focus on continuous improvement helped to foster a shift in mind-set among staff who were 'just used to making it to the end of the day' to building a stronger culture of safety."	Checklist associated with overall improved adherence to ≥4 (out of 6) safety processes, decreased surgical site infections (AOR 0.28, 95% CI 0.15-0.54), surgical complications (AOR 0.45, 95% CI 0.26-0.78). Stratified analysis revealed, improved adherence limited to Hospital 1 (AOR 4.06, 95% CI 2.2-7.6), decreased surgical site infections, surgical complications limited to Hospital 2. No improvement in surgical outcomes.

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Kasatpibal 2012[34]	Circulating OR nurse participated in 2 meetings and one day data collection training session.	From March 2009 to August 2009, 42.6% of operations selected for inclusion.

91% of patients confirmed identity, site, procedure & gave consent. Only 19% of surgical sites marked. Anesthesia equipment and medication checked in 90% of cases. Pulse oximeter applied in 95% of cases. Allergies, difficulty airway, aspiration risk and risk of >500 ml blood loss assessed in 100% of cases. | Compliance with marking of surgical site low because: marking materials unavailable, procedure was emergent, and "Thai culture" in which "Thais do not make marks on other people, especially on the head."

Also, "some surgeons assumed that wrong-site surgery would not occur because they had not experienced it themselves."

Compliance with hair removal procedures was hampered by lack of familiarity with proper procedure, lack of equipment and requests from surgeons. | Surgical teams often did not introduce themselves during time out for cultural reasons. "In Thai culture, people usually introduce themselves only when they first meet someone and are shy about publicizing their roles."

Compliance with checklist high for life threatening issues (drug allergies, difficult airways, profuse blood loss) and confirmation of patient's name, incision and procedure. Notably, standards for these measures are already current hospital policy.

Compliance was low for surgical site marking and appropriate hair removal. | NR |
| Bohmer 2012[30] | NR | Survey administered before checklist implementation, then 12 weeks after implementation. | All participating specialties were involved in formulation of the questionnaire.

The checklist was modified for "local conditions" based on feedback from staff.

Checklist introduced by department heads, demonstrating leadership.

Baseline findings and improvement after introduction of the checklist were presented to staff. | OR staff felt that communication culture in OR was improved, and checklist facilitated information about intraoperative complications. The authors observed there was more discussion of critical events between surgeons/anesthesiologists. | NR |

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Fourcade 2012[27]	NR Training sessions, written materials and videos available from the French National Authority for Health, but use by participating centers was not reported.	January 11-29 of 2010. Random sample of 80 records from medical record per center were analyzed. Excluded topical anesthesia, IR, GI endoscopy and CVC placement. Subsequent interviews with staff and surgeons via semi-structured interviews and email surveys.	Barriers to success: 1. Many elements of checklist already exist so checklist creates duplication. 2. Poor communication between surgeon/anesthetist. 3. Completing checklist took too much time, staff did perceive benefit. 4. Some items confusing because they did not fit in with customary operating room practices (or seemed inappropriately timed). 5. High staff turnover, new staff unfamiliar with checklist. 6. If OR staff not actively engaged during checklist, nurses felt concerned about "legal implications of signing the checklist as they might be held accountable for errors." 7. Some felt questions were repetitive, might frighten patients about to undergo anesthesia. 8. In 5 centers, box for checklist could be checked if safety check not performed for time constraints. Some staff worried this would make checklists fail to improve patient safety.	Checklist performed in 90.2% of surgeries. However, checklist was completed in only 61% of cases.	NR

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Perez-Guisado 2012[62]	NR	January to December 2010. Responsibility for sections of checklist was divided between nurses, anesthetists and surgeons.	Local 10 question checklist already in place, containing 8 items from WHO checklist.	Nurses achieved 99% implementation, but surgeons, anesthetists only completed checklists at 79% and 72% respectively.	NR
van Klei 2012[33]	Information provided in regular meetings to OR staff. Posters placed in all ORs and electronic systems.	January 1, 2007 to September 30, 2010. Checklist implemented April 1, 2009. Monthly compliance reports provided to team managers. OR circulating nurses designated in charge of checklist completion.	Checklist completion may be necessary for improved health outcomes. Checklist may be less likely to be completed in patients undergoing emergency surgery who are at higher risk of mortality. This raises methodologic questions of how to adjust for patient severity.	Checklist fully completed in 39% of all patients. Median number of items documented was 16.	After implementation, 30 day in house mortality decreased from 3.13% to 2.85%. Checklist associated with decreased odds of 30 day mortality (Adjusted OR 0.85, 95% CI 0.73-0.98). Incomplete checklist did not have a significant effect on mortality.
Takala 2011[63]	"Brief instructions on the use of the checklist were on the checklist backside. Written guidelines on how to use the checklist were also available. Instructions were given in order to avoid variation in the use of the checklist in different hospitals and operating theatres."	Study initiated in 2009. Nurses, anesthetists & surgeons surveyed regarding OR practices. Then, the checklist was implemented over 2-4 weeks. Finally, survey of OR practices repeated 4-6 weeks after checklist implementation.	NR	Nurses,anesthetists and surgeons reported increased confirmation of patient identity and awareness of names/roles of team members. Surgeons reported improvements in discussions of critical events with anesthesiologist (34.7 to 46.2%, p <0.001) and gave prescriptions and instructions to post-anesthesia care unit more often.	Implementation led to discovery of systematic error in timing of prophylactic antibiotics administration.

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Truran 2010[64]	NR	Checklist introduced April 2009. Study evaluated compliance with NICE venous thromboembolism prophylaxis guidelines for 3 week period prior to checklist implementation, and 6 months afterwards.	NR	Non-compliance with guidelines for venous thromboembolism prophylaxis decreased after checklist from 6.9 % to 2.1%.	NR
Vogts 2011[32]	NR	November to December 2010 Medical student observed 100 procedures, documented compliance.	Authors suggest compliance with "Sign out" section is low because 1) The timing is "not linked to a specific event in patient management" and 2) Nurses tasked with performing this section have many competing responsibilities at the end of procedure.	Compliance with "Sign in" and "Time out" sections of checklist was high. However, "Sign out" was only observed in 2/100 cases.	NR
Askarian 2011[35]	Checklist presented to OR head. Educational packages containing checklist & guidelines were distributed to surgeons, assistants, anesthetists & nurses. Checklist presented to OR teams.	Included all elective general surgeries 3 months prior to checklist, followed by 3 months after implementation (144 patients).	NR	Obtaining information for time out and sign out sections of checklist improved after checklist implemented.	Surgical complications (before discharge) decreased from 22.9% to 10% after checklist implementation. Surgical site infections decreased.

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Levy 2012[31]	All OR team members except physicians viewed a computer based training presentation one time. Large poster of checklist placed in every OR.	Direct observation of randomly selected non-emergent surgeries over 7 week period.	Inadequate education during implementation led to confusion regarding practical execution of checklist. (Unclear if physicians received any training). Checklist poster in OR lacked practical instructions for how checklist should be executed, including which team members questions are directed towards. Checklist was not adapted for pediatric patients and may have been less relevant.	Although electronic medical record reported 100% compliance only 4/172 cases completed more than 7 out of 13 checkpoints. Small post study survey of OR staff revealed confusion about proper timing of "timeout" and team member responsible for ensuring checklist execution.	NR

Author/Year	Training	Study Phases and Checklist Fidelity	Reasons for Success or Failure	Opinions, Knowledge and Behavior	Health Outcomes
Helmio 2012[15]	OR staff heard three informative lectures before participating in WHO pilot study. Specific guidelines on use of checklist were available in the OR. Brief instructions appeared on the back of the checklist.	Checklist implemented in September 2010. All surgeries (7,148) between September 2010 and August 2011 included. Survey administered October 2011.	Nurses reported "some senior otolaryngologists had negative attitudes towards the checklist". "Active leadership, regular audits and feedback are important for successful implementation and maintenance of a checklist."	Checklist completion rates were: sign in 62.3%, time out 61.1%, sign out 53.6%. 76% of OR team agreed checklist improved OR safety, 68% agreed it improved error prevention. 93% would want checklist used during their own surgery. "Disregard for checklist use was revealed in the open responses: 'answers are dismissive', 'it is noisy and staff is not concentrating on the checks'… One senior otolaryngologist wrote, 'Time out has never been performed in my operations'. In addition, there was confusion about who should lead each check section and when to do checks: 'I have never received the information on how to use the checklist.' Positive comments included 'the checklist is beneficial', 'it should always be used' and 'nowadays no operation should be varied out without the checklist'.	NR

Table notes: NR-Not reported; Int-Intervention; OR-Operating room; GI-Gastrointestinal; GYN-Gynecology; AOR-Adjusted odds ratio

Table 4. Studies of wrong-site-surgery checklists implementing the Universal Protocol

Author/Year	Description of PSP	Study Design	Theory or Logic Model	Description of Organization	Safety Context	Implementation Details
Garnerin et al. 2008[37]	Verification protocol for checking patient identity and the site of surgery	Case series	"…the prevention of wrong patients and wrong site surgery, not to mention accountability, demanded an intervention aimed at improving the way both patient identity and site of surgery checks were performed, while acquiring the ability to identify and correct deficiencies"	Swiss anesthesiology service located within a 1,200 bed university hospital	Prior to introduction of the checklist, all patients were required to wear ID bracelets, and the operative site had to be signed by the surgeon. Anesthesiologists were made aware that they were being monitored.	Verification protocol developed by an interdisciplinary team. It required patients to state their identity, comparing the statement to the ID bracelet, OR schedule, and medical record. Similar types of checks for correct site of surgery. Nine consecutive months of data were obtained (October 2003 to June 2004), and later three subsequent months (October 2004, March 2005, and October 2005). Compared to the first three months of implementation, the next three months saw better compliance in checking patient identify (63% up to 81%), complete compliance with identity checks (10% up to 38%), proportion of surgical site checks performed (77% up to 93%), and complete compliance with surgical site checks (32% up to 52%). Compliance was stable in subsequent periods. Authors attributed the improvements to increased use of wristbands upon admission into the OR, the switch from to using an open-ended questioning format, and the use of three different sources for verification. Barriers included 1) surgeons saying they already knew that patients or the surgical site was obvious, and 2) the failure to develop the protocol with the input of ALL surgical services

Author/Year	Description of PSP	Study Design	Theory or Logic Model	Description of Organization	Safety Context	Implementation Details
Nilsson et al. 2010[38]	Preoperative "time-out" checklist	Questionnaire after implementa-tion	None explicitly stated	Two Swedish hospitals, bed sizes not reported	In the autumn of 2007, there were two incidents of wrong-side surgery at these hospitals, and a root-causes analysis suggested that a time-out procedure might help. The checklist was pre-approved by the heads of the operating and anesthesia departments.	Implementation began in December 2007. Checklist was a shared responsibility of the OR team. One year later, a questionnaire was sent to all 704 surgeons, anesthesiologists, operation nurses, anesthetic nurses, and nurse assistants, soliciting their opinions about the new time-out checklist. Of the 331 responders, 93% felt that the checklist contributes to increased patient safety (either "without a doubt," or "probably"). When asked about eight specific components of the time-out checklists, the percentage of respondents who felt the component was "very important" varied widely, from a low of 14% for the introduction of team members to highs of over 80% for patient identity, correct procedure, and correct side. Regarding the sign-out, 91% felt that the item involving the count of surgical instruments and sponges was very important.

Author/Year	Description of PSP	Study Design	Theory or Logic Model	Description of Organization	Safety Context	Implementation Details
Owers et al. 2010[39]	Correct site surgery checklist incorporate into an existing surgical checklist	Case series	None explicitly stated	English children's hospital, bed size not reported	A surgical checklist already existed at this facility; they added a correct site surgery component	Five people were required to sign the documentation: marking surgeon, operating surgeon, ward nurse, scrub nurse, and anesthetist. Two audit cycles: once in 2006 (sooner after implementation) and once in 2008 (two years later).

Comparing 2008 to 2006, correct completion of the eight items was not at all improved for four items (ward nurse signed, operating surgeon signed, scrub nurse, signed, and operating department practitioner signed) but was improved for the other four (mark site documented, no mark required documented, entries legible, and marking surgeon signed).

"The lack of documentation, of course, may not reflect that the new guidance and processes are not being followed, but rather that the documentation is regarded as a low priority part of the process." |
| Anonymous 2007[37] | Checklist to implement the Universal Protocol, tailored to this hospital's preferences and procedures | Case series | Stated that the checklist provides cues for staff when preparing for a procedure. | Hospital in North Carolina, bed size not reported | Before this checklist, they were using a "cumbersome form" to document their compliance with the Universal Protocol. | Original checklist in 2005, minor revisions for 2006. Demonstrated the checklist during educational staff meetings, and new staff were given a primer. Staff gave positive comments that they no longer had to remember everything. The completed checklist is kept as part of the medical record. |

Table notes: NS-Not stated; Int-Intervention